The Impact of E-commerce on Farmers' Income A Propensity Score Matching Analysis in Mei County, China

Xinzhi ZHANG

School of Economics and Management, Northwest University, Xi'an, China; 1294643363@qq.com

Abstract: This research examines the impact of e-commerce adoption on the rise of farmers' income using household survey data from kiwifruit growers in Mei County, Shaanxi Province and the propensity score matching technique (PSM). According to the study's findings, the adoption of electronic commerce has a positive effect on farmers' income. Further, capital accumulation appears to have a remarkable impact on the income-increasing impact of e-commerce adoption, and different capital stocks will result in varying income-increasing effects. Accordingly, the government should attach importance to the decisive role of e-commerce, help farmers establish a stable sales network to improve the income of farmers and enhance the quality of their life.

1. Introduction

With the rapid growth of the Internet in recent years, e-commerce as a new method of selling has made a significant influence on people's lives. According to the Statistical Report on China's Internet Development, the number of Internet users in China surpassed 900 million by the end of 2019, with 99.3 percent using mobile phones, and 700 million online shoppers. Among them, there are 255 million Internet users reside in rural areas, laying the groundwork for the rapid growth of "Internet plus agriculture". China's rural internet retail sales hit 205 million in 2021, and rural e-commerce penetration is growing.

Due to the convergence of information technology and agricultural development, agriculture e-commerce is inevitable. In recent years, the favorable influence of e-commerce on rural economies has increased. Developing agricultural e-commerce is a crucial step in fostering the advancement and transformation of rural industries worldwide. At the micro level, e-commerce can break the long-term structure of information asymmetry (Song et al., 2022) and expand the range of consumers' choices (Hu et al., 2022).

At present, there are two kinds of e-commerce models widely used in agricultural products market: "platform e-commerce" and "interpersonal trust e-commerce". Taobao is a typical example of the first one. With rather sophisticated technology, Taobao's e-commerce infrastructure includes a user feedback system, an appeal and arbitration system, dependable third-party services, and Alipay, a secure payment system (Li & Chua, 2016). In contrast, the second type is mainly based on interpersonal trust represented by WeChat business

(accounting for about 90 percent of this type). WeChat is one of the least technically demanding businesses in the e-commerce business model. It breaks the platform fees charged by three parties and relies more on individual social networks and interpersonal trust. Compared with traditional rural market transactions, it has a wider scope and wider market audience (Hu et al., 2022), and individuals and merchants can carry out business with a small cost (Li, 2020). The "E-commerce Law of the People's Republic of China" went into effect on January 1, 2020, and WeChat commercial industry was formally included in the scope of network supervision. This means that WeChat business will gradually normalize and legitimize (Zhuang & Chen, 2020). Therefore, the development of WeChat business of agricultural products is an inevitable trend (Wang & Zhou, 2016).

Nevertheless, most of the existing literature involves market research and policy research, and micro empirical analysis is lacking. Therefore, this article focuses on the impact of WeChat operation on farmers' income, which is innovative to a certain level. In this work, the PSM method, which is extensively employed in the study of agricultural micro effect analysis, is chosen to examine the effect of WeChat business on farmers' income. It is widely employed to address the issue of selection bias and biased estimates resulting from "self-selection" of samples, such as Li et al. (2021); Li et al. (2017).

The goal of this article is to investigate the income-enhancing effect of WeChat business on farmers, including total revenue and revenue per capita, and to test the difference of income increasing effect under different capital ownership. Specifically, the PSM matching approach is used to quantify the influence of WeChat operation on farmers' income growth by matching the number of the family labor force, kiwifruit planting experience, health status, cultivated area, family prestige, social network, the main source of family income, whether family members are leading cadres, whether they are kiwifruit planting demonstration households and whether they actively collect wealth information. In terms of research of increasing effect of income difference, we use physical capital, human capital, and social capital as grouping variables to study.

The section 2 provides an overview of the PSM approach, data sources, and variable selection in this paper. The empirical results, stationary test, and sensitivity analysis are presented in the section 3. And section 4 gives some conclusions and enlightenment.

2. Method Data and Variables

2.1. Empirical Methods

In this research, the PSM approach is used to examine the influence of e-commerce sales on the income of farmers, and the following measuring model is developed:

$$Y_i = \alpha + \delta D_i + \beta X_i + \varepsilon_i \tag{1}$$

Where i refers to different farmers; Y_i refers to farmers' agricultural income; D_i is a dummy variable indicating whether to use e-commerce for purchasing and selling activities. If i is an adopter, $D = 1$, otherwise, $D = 0$; X is a vector of other additional explanatory

variables; α is the constant term, and ε_i is the random interference term. The symbol δ represents the income impact of e-commerce adoption.

Propensity score matching (PSM) is the primary strategy for addressing the issue of self-selection. In this study, we will apply the PSM approach to address the self-selection problem of farmers' adoption of e-commerce, which is based on a sample of farmers who do not engage in e-commerce. Each e-commerce farmer is paired with a non-e-commerce farmer whose attributes are similar to those of the e-commerce farmer except for differences in e-commerce adoption behavior. Consequently, the result variables of two sample subjects can be views as the outcomes of two distinct experiments conducted by the same farmer (adopting e-commerce and not adopting e-commerce). The difference between the outcome variables represents the net effect of the adoption of e-commerce. The net effect for the entire group of e-commerce farmers is known as the average treatment effect of the treated (ATT), and its expression is:

$$ATT = E(Y_1|D = 1) - E(Y_0|D = 1) = E(Y_1 - Y_0|D = 1) \qquad (2)$$

Where Y_1 represents the amount of agricultural income following the adoption of e-commerce, and Y_0 refers to the agricultural income level when the farmers do not adopt e-commerce. Only $E(Y_1|D = 1)$ can be observed; $E(Y_0|D = 1)$ is an unobservable counterfactual result, so it is necessary to use the PSM method to construct its alternative index.

PSM is mainly based on observable explanatory variables and the unobservable factors that affect decision variables do not play a direct role. If the observable variables are not set correctly, the unobservable characteristics will lead to biased estimation of tendency score and wrong sample matching (Heckman & Navarro-Lozano, 2004). In this paper, the sensitivity analysis method proposed by Rosenbaum (2002) was used to test the influence of unobvious factors. Because the method is difficult to directly measure the potential bias error, that is, to assess the sensitivity of a set of unobservable factors to a change in the magnitude of action of the probability of treatment.

We also categorize farmers using PSM to explore the variations between groups in terms of the impact of e-commerce adoption. Group comparisons in PSM were used to study the differences in the treatment effect among groups. There is no lack of precedents in academic circles, such as Li et al. (2021). In this paper: according to the grouping variables (material capital, human capital and social capital), the total sample is first divided into several subsamples; next, PSM analysis is carried out for each subsample; ultimately, ATT of each sub-sample is obtained, and the difference between groups is analyzed.

2.2. Data Source

In January 2020, kiwifruit farmers in Mei County, Baoji City, Shaanxi Province were surveyed as part of a household survey for the purposes of this paper. Kiwifruit in Mei County is a geographical indication product of agricultural products of the Ministry of Agriculture, which has been selected into China's agricultural brand catalogue, with a brand value of 12.833 billion yuan. By the end of 2019, the planting area of Kiwifruit in Mei County has reached 302 thousand mu (one-seventh of China's total kiwi planting area), with kiwifruit

production covering all administrative villages in Mei County. Farmers in the county have planted 4.5 mu kiwifruit per household on average, 1.16 mu per capita, and there are more than 120 thousand kiwifruit employees. (In China, "mu" is the municipal land area unit. One mu is equivalent to 60 square abbot, roughly 666.667 square meters.) The total output is 495 thousand tons, the output value of fresh fruit is 3.1 billion yuan, and the overall output value is 5.2 billion yuan. Kiwifruit has become the pillar industry for farmers to increase their income and become rich in Mei County.

To meet research needs, we limited the selected survey object to kiwifruit growers in Mei County. In December 2019, 8 undergraduates conducted a one-week face-to-face survey in Mei County. We selected 7 villages for investigation on consideration of the distance from the center of the county. In each village, researchers are required to randomly visit 3 WeChat business farmers and 6 non-WeChat business farmers. Theoretically speaking, the number of non-WeChat business farmers is larger than that of WeChat farmers, which is more conducive to the success of sample matching (Li et al., 2021). Therefore, a total of 504 questionnaires were distributed, consisting of 168 surveys to WeChat business farmers and 336 questionnaires to non-WeChat business farmers. After eliminating the questionnaires with missing data and extreme values, the sample size of PSM analysis is 138 WeChat farmers (82.1% efficiency), 290 non-WeChat business farmers (86.3% efficiency), a total of 428 (84.9% overall efficiency).

2.3. Descriptive Analysis

Before giving descriptive analysis, it is crucial to describe the most significant variables utilized in the study. The study's primary variable, farmer income, was measured by gross income or per capita income. Total revenue refers to the sum of kiwi fruit sales through and outside of WeChat platforms by households in 2019. And per capita income refers to the kiwi sales income per household member in 2019 and is calculated by dividing the total household income in 2019 by the quantity of household members participating in the industry.

For the matching variables of PSM, this paper adopts the selection idea based on the theory and previous experience research, guided by the matching effect. The final selected matching variables include the number of family labor (Zhou, 2013), kiwifruit planting experience (Tang & Zhou, 2018; Tang, 2017), the main source of family income, whether family members are leading cadres (Zeng et al., 2019), whether they are kiwifruit planting demonstration households, family cultivated area (Tang & Zhou, 2018), and health status (Tang & Zhou, 2018), family prestige (Tang, 2017) and social network (Tang & Zhou, 2018). Family prestige refers to the individual perception of the family's prestige in the village, and a social network refers to whether the farmers are willing to expand their social network actively. Specifically, the variable Y_1, which represents the average total income of sample farmers, is 51,757.53 yuan. The variable Y_2, which represents per capita income, is 11,127.53 yuan.

Table 1 displays the descriptive analysis findings for all variables. The samples are divided into WeChat business adopters and WeChat business non-adopters. It can be seen that in the result variable, the total income of the adopters is 76,395.80 yuan, and the per capita income is 16,623.17 yuan. The adopters were 36,322.40 yuan and 8,101.81 yuan more than the non-adopters. Then it comes to matching variables, the two groups of farmers

showed remarkable differences in kiwifruit planting experience, social network, the main source of family income, whether family members are leading cadres, whether they are kiwifruit planting demonstration households, the cultivated area, and health status. However, there is no statistically significant difference between farmers who utilize e-commerce and those who do not in terms of family prestige and labor force size.

Table 1. Descriptive statistics of variable differences

Variable type	Variable name	E-commerce adoption		Non-adoption		Mean difference (T test)
		Mean	S.D.	Mean	S.D.	
Outcome variables	Total revenue	76,395.80	9,088.34	40,073.40	1,622.61	-5.44***
	Revenue per capital	16,623.17	2,151.64	8,521.36	377.65	-5.13***
Matching variables	Kiwifruit planting experience	13.56	0.52	12.05	0.37	-2.32**
	Social network	0.72	0.04	0.57	0.03	-2.88***
	The main source of family income	1.41	0.10	1.16	0.04	2.61***
	Whether there are leading cadres	0.12	0.03	0.05	0.01	-2.41**
	Demonstration household or not	0.12	0.03	0.06	0.01	-2.33**
	Cultivated area	5.09	0.27	4.54	0.11	-2.19**
	Health status	3.93	0.06	3.79	0.05	-1.85*
	Family prestige	3.33	0.09	3.27	0.05	-0.52
	The number of family labor	2.90	0.09	2.74	0.06	1.58

Note: *, **, and *** are significant at the levels of 10%, 5%, and 1%, respectively.

3. Analysis of Empirical Results

3.1. Farmers' Estimation of the Adoption Choice Equation for Interpersonal Trust E-commerce

Table 2 displays the estimation results of the Logit model. It can be seen that social networks, the main source of family income, whether there are leading cadres in the family, family prestige, and cultivated area significantly affect the adoption of interpersonal trust e-commerce. In addition, although the regression coefficient is positive, the kiwifruit planting experience, the number of the family labor force, whether it is a planting demonstration household and the health status have not passed the significance test.

Table 2. Logit model-based estimation of the adoption decision equation for e-commerce

	Coefficient	Standard error	Z statistic
Kiwifruit planting experience	0.03	0.02	1.64
Social network	0.64**	0.26	2.48
The main source of family income	0.32***	0.11	2.86
Whether there are leading cadres	0.91**	0.42	2.18
Family prestige	0.25 *	0.14	-1.85
The number of family labor	0.11	0.11	0.98
Demonstration household or not	0.71	0.38	1.88
Cultivated area	0.06 *	0.05	1.23
Health status	0.20	0.15	1.31
Constant term	-2.59 ***	0.73	-3.53
Pseudo R2	0.0633		
LR statistics	34.07		
Sample capacity	428		

Note: *, **, and ***are significant at the levels of 10%, 5%, and 1%, respectively.

3.2. Balance Test

There will inevitably be a "shared support region" overlap between the propensity scores of WeChat business farmers and non-WeChat business farmers. The probability of sample loss decreases as the extent of the standard support domain increases. In order to make the best use of the samples of WeChat farmers, different matching methods will produce different sample loss. In this study, we select four matching algorithms: nearest neighbor matching (1:1 matching), nearest neighbor matching (1:2 matching), kernel matching (window width = 0.06), and kernel matching (window width = 0.09). Among the above four matching methods, the sample loss of WeChat farmers is minimal, so the common support domain condition is satisfactory.

The results of the balance test for explanatory factors before and after matching are shown in Table 3. As can be seen, the standard deviation of most explanatory variables after matching has been dramatically reduced. For all explanatory variables, it was within 10%. After matching, there was no significant difference in all explanatory variables between the treated and the controlled. As can be seen from Table 3, the pseudoR2 value decreased from 0.064 before matching to 0.001–0.012 after matching. LR statistics decreased from 34.31 before matching to 0.31-4.64 after matching. The joint significance test of explanatory factors went from being highly significant to being consistently rejected at a threshold of 10%. From 20.6% to 1.6–6.4%, the mean deviation of explanatory factors decreased. The median deviation was reduced from 22.5% to 1.2–6.0% and the total deviation was also significantly reduced. The aforementioned test findings indicate that inclination score estimation and sample matching are successful, and that matching WeChat adopters are comparable to non-adopters.

Table 3. Balance test results of explanatory variables before and after matching

Matching method	Pseudo R2	LR statistics	P-value	Mean difference (%)	Median difference (%)
Before matching	0.064	34.31	0.00	20.6	22.5
Nearest neighbor matching (1:1 matching)	0.012	4.64	0.87	6.4	6.0
Nearest neighbor matching (1:2 matching)	0.006	2.45	0.98	4.8	3.8
Kernel matching (window width = 0.06)	0.001	0.31	1.00	1.6	1.2
Kernel matching (window width = 0.09)	0.002	0.68	1.00	2.6	2.2

3.3. Measurement Results of Income Increasing Effect of Interpersonal Trust E-commerce Adoption by Farmers

Table 4 reports the total revenue, revenue per capita, and ATT value of the treated and the controls by using four matching methods, respectively. Consequently, the results produced using various matching approaches are fairly similar, and the 1% significance test has been passed for the ATT value of total revenue and revenue per capita. Due to the implementation of WeChat business, per capita income and total income increased by 7,497.3 and 33,744.21 yuan, respectively. The increase in revenue per capita income accounts for

Table 4. The measurement results of income increasing effect

Matching method	Revenue per capita (yuan)			Total revenue(yuan)		
	Treated	Controls	ATT	Treated	Controls	ATT
Before matching	16,623.17	8,525.91	8,097.25***	76,395.80	40,112.27	36,283.53***
Nearest neighbor matching (1:1 matching)	16,623.17	9,545.69	7,077.48***	76,395.80	42,539.49	33,856.31***
Nearest neighbor matching (1:2 matching)	16,623.17	9,343.52	7,279.64***	76,395.80	42,661.23	33,734.58***
Core matching (window frame = 0.06)	16,616.97	8,778.72	7,838.26***	75,805.66	42,003.51	33,802.15***
Core matching (window frame = 0.09)	16,616.97	8,820.61	7,796.36***	75,805.66	42,221.87	33,583.79***
Mean value	16,620.07	9,122.14	7,497.93	76,100.73	42,356.52	33,744.21

Note: *, **, *** are significant at the level of 10%, 5% and 1% respectively; the significance test results of ATT value are obtained by self-service method.

82.19% of the total revenue of non-adopters, and the increase in total revenue accounts for 79.67% of the total revenue of non-adopters. Hence one can see that the adoption of WeChat business can markedly improve the revenue per capita and total revenue.

The research findings indicate that the implementation of e-commerce based on interpersonal trust can boost the agricultural revenue of farmers. Farmers who accept interpersonal trust e-commerce have a greater income per capita and total revenue than those who do not. The new development of rural e-commerce is gradually making it possible for Chinese farmers to share digital dividends. Interpersonal trust e-commerce is also gradually increasing the income of farmers.

Table 5. Sensitivity analysis of total income ATT of WeChat business farmers

Gamma	sig+	sig-	t-hat+	t-hat-	CI+	CI-
1.0	0.000	0.000	16,690.0	16,690.0	9,606.00	24,960.0
1.1	0.000	0.000	15,014.5	18,455.1	7,847.25	26,975.0
1.2	0.000	0.000	13,214.5	20,410.0	6,223.50	28,930.0
1.3	0.001	0.000	11,830.0	22,180.0	4,720.00	30,696.5
1.4	0.002	0.000	10,575.0	23,650.0	3,400.00	32,395.0
1.5	0.006	0.000	9,200.0	25,260.0	2,070.00	34,330.0
1.6	0.013	0.000	8,145.0	26,595.0	1,000.00	36,125.0
1.7	0.026	0.000	7,114.5	27,818.5	-100.00	37,862.3
1.8	0.047	0.000	6,125.0	29,083.5	-1,150.00	39,600.0
1.9	0.078	0.000	5,315.0	30,200.0	-1,945.00	41,125.0
2.0	0.118	0	4,210.0	31,259.6	-2,950.00	42,517.0
2.1	0.168	0	3,423.5	32,345.0	-3,750.00	44,107.0
2.2	0.228	0	2,650.0	33,494.5	-4,600.00	45,553.5
2.3	0.294	0	1,895.0	34,637.0	-5,504.00	47,150.0
2.4	0.364	0	1,200.0	35,650.0	-6,165.00	48,750.0

3.4. Sensitivity Analysis

Table 5 displays the results of a sensitivity analysis comparing the rate of WeChat business adoption to total income, where the gamma coefficient indicates the impact of overlooked factors on adoption of interpersonal trust e-commerce by farmers. If the conclusion is not statistically significant when the gamma coefficient is close to 1, the PSM

result cannot stand up to examination. If the conclusion is not statistically significant when the gamma coefficient is large (often close to 2), then the PSM result is acceptable (Rosenbaum & Rubin, 1983). As can be seen, when the gamma coefficient increases to 1.9, the existing conclusions become insignificant at the level of 0.05. Logically, it is possible to claim that projected revenue based on PSM technology is insensitive to unobtainable elements, which mitigates our fear that unobtainable factors may have a large impact on estimated revenue.

3.5. An Analysis of the Difference of the Effect of Increasing Income on the Adoption of Interpersonal Trust E-commerce by Farmers

According to the analysis and forecast of China's economic situation in 2016, China's urban-rural income gap has narrowed, but the rural internal income gap has widened (Li et al., 2018). In the same location and sector, social capital, physical capital, and human capital will influence the income-enhancing effect of e-commerce adoption among farmers, resulting in income-enhancing effects of e-commerce that vary among farmers (Zeng et al., 2019). This article studies the difference in the income-increasing effect of the adoption of interpersonal trust e-commerce in rural families in an effort to ameliorate the phenomena of the rising income gap in rural areas, narrow the digital divide, and also reduce the income gap.

For the variables used for PSM group comparison, we use the cultivated area to reflect the material capital factors (Xia & Zhang, 2018); frequency of learning sales skills to reflect human capital factors (Deng & Xia, 2019; Tang, 2017); expenses for gifts, the number of mobile phone contacts and family prestige represent social capital factors (Tang, 2017; Zeng et al., 2019; Tang & Zhou, 2018). The frequency of learning sales skills refers to the frequency of farmers actively searching and learning sales skills, expenses for gifts refer to the gift money that farmers spend every year due to relatives' and friends' weddings and funerals during the past three years. The number of mobile phone contacts refers to the main kiwifruit sales publicists of the family.

Due to the small sample size, we divide all data into two groups for each grouping variable in order to assure the matching effect. For continuous grouping variables, we first calculate their mean value and then divide them into two sample groups "greater than the mean value" and "less than or equal to the mean value" for PSM.

According to existing knowledge, for agricultural income, the land owned by farmers is the essential physical capital and carrier for planting and harvesting. The amount of land owned directly affects the income of farmers (Xia & Zhang, 2018). For this reason, we select the cultivated area to reflect the factors of physical capital, and group it according to the above-average level and below or equal to the average level to study the difference of income increasing effect. In addition, human capital investment in education and training can increase the accumulation of human capital, improve the scientific and cultural literacy of workers, improve agricultural labor productivity and promote the growth of farmers' income (Huang, 2005; Deng & Xia, 2019). Accordingly, we select the frequency of daily learning sales skills to reflect the human capital factors of farmers and divides them into never or general and positive or more positive groups according to the learning frequency to study the difference of income increasing effect.

In addition, maximizing the information advantages of traditional social capital, for example, blood relationship and geographical relationship network, can increase the income of farmers and encourage the growth of rural economies (Liu, 2018; Tang & Zhou, 2018). Therefore, we choose expenses for gifts, mobile phone contacts, and family prestige to measure social capital factors. They were compared according to the above-average level and below or equal to the average level in order to explore the difference of income increasing effect of interpersonal trust e-commerce.

Table 6 reveals that after the adoption of WeChat business, farmers whose cultivated area is higher than the average increase by 10,869.49 yuan and 40,996.00 yuan in per capita sales income and total income respectively; and yet farmers whose cultivated land area is lower than or equal to the average increase 5,454.19 yuan and 27,584.59 yuan in per capita sales income and total income respectively. It can be deduced that household cultivated area has a substantial favorable influence on the effect of implementing WeChat business on raising income.

For families with more cultivated land, the main source of their income is agricultural income. Undoubtedly, they will invest more labor force in agricultural production, which makes the effect of increasing income more significant. For the frequency of learning sales skills, after adopting WeChat business, farmers who actively learn sales skills increase 11,639.52 yuan and 49,921.20 yuan in revenue per capita and total revenue, respectively. However, others only increased by 6,033.60 yuan and 25,757.71 yuan, respectively.

As for the number of mobile phone contacts, the results show that after the adoption of WeChat business, farmers whose mobile phone contacts are more than the average increase by 10,520.6 yuan and 54,037.72 yuan revenue per capita and total revenue respectively. By comparison, others only increased by 6,614.14 and 24,461.17 yuan, respectively. Consequently, the number of mobile phone contacts has a substantial beneficial influence on the growth of WeChat's commercial revenue. In China's rural society, the main way of communication and exchange is also telephone contact. That is to say, to some extent, the number of mobile phone contacts can reflect the scope of farmers' access to information and the level of their ability to access information. The more comprehensive information access channels and information there are, the more favorable they are to farmers' knowledge of e-commerce sales channels, so encouraging farmers to sell agricultural goods via interpersonal trust e-commerce sales channels and enhancing family income.

In terms of family prestige, the results show that after adopting WeChat business, farmers with higher family prestige increase by 8,359.53 yuan and 40,529.59 yuan in revenue per capita and total revenue respectively, and yet farmers with lower family prestige only increased 7,667.54 yuan and 28,311.69 yuan, respectively.

In terms of expenses for gifts, the results show that after adopting WeChat business, farmers whose gift expenses are higher than the average increase by 12,847.01 yuan and 54,132.32 yuan in revenue per capita and total revenue respectively. However, others increased by only 4,766.49 yuan and 22,278.71 yuan, respectively. Evidently, family prestige and expenditures for presents have large beneficial effects on the revenue growth of WeChat

businesses, indicating that the relationship social capital based on blood and location still plays an important role in the rural areas of our nation.

Physical capital, human capital, and social capital considerably influence the income-increasing effect of farmers' adoption of interpersonal trust e-commerce, as determined by the PSM group comparison. Nonetheless, the wealth disparity within the farmer group will always exist. It can even be said that the application of information technology, represented by e-commerce, has become an essential source of income gap within farmers to a certain extent.

Table 6. Influencing factors of income increasing effect difference of e-commerce adoption

Variable	Grouping	Revenue per capita			Total revenue		
		Treated	Controls	ATT	Treated	Controls	ATT
Cultivated area	>Mean	22,144.49	11,274.99	10,869.49***	97,626.15	56,630.15	40,996.00***
	≤Mean	12,142.00	6,687.81	5,454.19***	57,748.33	30,163.75	27,584.59**
Learning sales skills	Positive	21,014.78	9,375.26	11,639.52**	93,448.78	43,527.58	49,921.20**
	Negative	14,468.38	8,434.78	6,033.60***	66,836.15	41,078.43	25,757.71***
Phone contacts	>Mean	18,454.41	7,933.81	10,520.60***	93,491.73	39,454.00	54,037.72**
	≤Mean	15,979.69	9,365.55	6,614.14***	67,774.36	43,313.20	24,461.17***
Family prestige	>Mean	17,484.45	9,124.92	8,359.53**	85,442.74	44,913.14	40,529.59**
	≤Mean	15,883.02	8,215.49	7,667.54**	66,286.12	37,974.42	28,311.69***
Expenses for gifts	>Mean	22,002.87	9,155.86	12,847.01***	96,954.08	42,821.76	54,132.32***
	≤Mean	13,499.99	8,733.49	4,766.49**	63,557.35	41,278.64	22,278.71***

Note: *, **, and *** are significant at the levels of 10%, 5%, and 1% respectively.

4. Conclusion and Enlightenment

This research offers empirical evidence that e-commerce can increase the revenue of farmers.

The results indicate that the adoption of electronic commerce based on interpersonal trust can substantially raise and boost the revenue of farmers. Also, the different capital endowments of farmers result in differences in income increasing effect. Based on survey data of kiwifruit farmers in Mei County, Baoji City, Shaanxi Province in January 2020, we have demonstrated that e-commerce platforms may be used to increase and promote the income of farmers.

In China, the development of rural interpersonal trust e-commerce is a crucial aspect of agricultural modernization, as it optimizes the production, sales, and circulation of agricultural goods and promotes the growth and expansion of the rural economy. In addition, farmers should teach themselves how to acquire information, particularly regarding e-commerce sales. And in this process, to reinforce and increase the understanding of e-commerce behavior involvement. To encourage the growth of a paradigm of e-commerce based on interpersonal trust in rural areas. This is the only method for farmers to directly reap the income-boosting benefits of e-commerce. What's more, social capital, as significant as physical capital and human capital, must be paid more attention to the impact of interpersonal trust e-commerce behavior of farmers. In addition to maximizing the benefits of existing social networks, we should also mobilize more comprehensive social resources with the aid of modern social capital, introduce new technology, and increase farmers' income.

Conflict of interest: none.

References

Deng, M. M., & Xia, Y. L. (2019). Human Capital, Social Capital and Rural Poverty Reduction: An Empirical Study Based on CGSS Micro-survey Data. *Journal of Huaibei Normal University (Philosophy and Social Sciences Edition), 40*(1), 48-54. https://doi.org/10.3969/j.issn.2095-0683.2019.01.009

Heckman, J., & Navarro-Lozano, S. (2004). Using Matching, Instrumental Variables, and Control Functions to Estimate Economic Choice Models. *The Review of Economics and Statistics, 86*(1), 30-57. https://doi.org/10.1162/003465304323023660

Hu, J. Y., Xiao, Y. Z., Tan, D. N., Liu, C. C., & Yao, J. Q. (2022). How Can WeChat Business Help Smallholders? - Based on the Case Study of Dangshan County. *Journal of China agricultural university (social science edition), 39*(05), 93-113. https://doi.org/10.13240/j.cnki.caujsse.2022.05.010

Huang, B. Z. (2005). Human-capital Investment in Rural Areas and Farmers Income Increase in China. *Journal of Huadong University of Technology (Social science edition), 20*(2), 57-61. https://doi.org/10.3969/j.issn.1008-7672.2005.02.011

Li, X. K., Guo, H. D., Jin, S. Q., Ma, W. L., & Zeng, Y. W. (2021). Do farmers gain internet dividends from e-commerce adoption? Evidence from China. *Food Policy, 101.* https://doi.org/10.1016/j.foodpol.2021.102024

Li, X. S., Wang, C., & Wu, M. L. (2018). Research on the Relationship between Rural Finance and Household Internal Income Gap. *Rural Economics and Science and Technology, 29*(23), 100-102. https://doi.org/10.3969/j.issn.1007-7103.2018.23.042

Li, Y. X., Dai, Z. Y., & Ding, S. J. (2017). Impact of Rural Industry Convergence on Rural Household Income-PSM Analysis Based on Survey of 345 Rural Households. *Journal of Huazhong agricultural university (social sciences edition), 04*, 37-44 + 146-147. https://doi.org/10.13300/j.cnki.hnwkxb.2017.04.006

Li, Z. Y. (2020). Research on the Development status of WeChat Marketing in Hengyang City-Taking Tea marketing as an example. *Fujian Tea, 42*(05), 37-38. https://doi.org/10.3969/j.issn.1005-2291.2020.05.022

Li, Z., & Chua, C. E. H. (2016). A Cultural Analysis of the Difference Between Interpersonal Trust and Institutional Trust. *PACIS 2016 Proceedings,* 366. https://aisel.aisnet.org/pacis2016/366

Liu, Y. (2018). Study on the Impact of Social Capital on Peasant Household Income in the Process of China's Modernization-Based on the Data of China General Social Survey (CGSS2012). *Rural Economics and Science and Technology, 29*(3), 118-119, 129. https://doi.org/10.3969/j.issn.1007-7103.2018.03.049

Rosenbaum, P. R. (2002). *Observational Studies.* Springer.

Rosenbaum, P. R., & Rubin, D. B. (1983). The Central Role of the Propensity Score in Observational Studies for Causal Effects. *Biometrika, 70*(1), 41-55. https://doi.org/10.1093/biomet/70.1.41

Song, Y., Xie, H., & Wang, Y. F. (2022). Can E-commerce of Agricultural Products Increase Famer's Income in Poverty Areas? Impacts of Heterogeneous Participation Patterns of Farmers. *Agricultural technology economy, 321*(01), 65-80. https://doi.org/10.13246/j.cnki.jae.2022.01.005

Tang, L. Q. (2017). Rural Social Capital and Electronic Commerce Transaction Platform. *Journal of South China Agricultural University (Social Science Edition), 16*(4), 75-86. https://doi.org/10.7671/j.issn.1672-0202.2017.04.008

Tang, L. Q., & Zhou, J. (2018). Social Capital, Information Acquisition and Farmers' Behavior of Electronic Commerce. *Journal of south China agricultural university (social sciences edition), 3,* 73-82. https://doi.org/10.7671/j.issn.1672-0202.2018.03.007

Wang, H., & Zhou, Y. N. (2016). Analysis of the Impact of Agricultural Derivative on Express Logistics—A Case Study of Mei County Kiwifruit Planting Area. *Logistics science and technology, June,* 70-71, 81. https://doi.org/10.3969/j.issn.1002-3100.2016.06.020

Xia, Y. L., & Zhang, Y. (2018). Influence of Family Endowment on Farming Household's Income: An Empirical Analysis Based on 1188 Households. *Journal of Agriculture and Forestry Economics and Management, 17*(4), 427-433. https://doi.org/10.16195/j.cnki.cn36-1328/f.2018.04.50

Zeng, Y. W., Chen, Y. F., & Guo, H. D. (2019). Previous Experience, Social Capital and Smallholders' E-commerce Adoption. *Agricultural technology economy, 2019*(03), 38-48. https://doi.org/10.13246/j.cnki.jae.2019.03.004

Zhou, Y. X. (2013). The Role of Social Capital in the Income of Rural Household: Evidence from CHIPS2002. *Economic review, 2013*(04), 47-57. https://doi.org/10.19361/j.er.2013.04.006

Zhuang, E. P., & Chen, L. (2020). Discussion on Problems and Countermeasures of WeChat Business Development in China. *Rural Economy and Science and Technology, 31*(4),146-147. https://doi.org/10.3969/j.issn.1007-7103.2020.04.087